



BLOSSOMS NGSS LESSON

Target Grade: High School	Lesson Title: Hanging by a Thread Developed by: Frank Lenox East Greenwich High School East Greenwich, Rhode Island
Course: Physics – Physical Science	
<p>State Standard – NGSS Performance Expectation HS PS2-1: Motion and Stability, Forces and Interactions Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]</p>	
<p>Lesson Performance Expectations</p> <ul style="list-style-type: none"> ● Students will apply their understanding of Newton’s Laws to explain a phenomenon. ● Students will develop a model to explain the cause and effect of two strings being pulled with unequal forces acting upon 2 identical masses. ● Students will plan and conduct an investigation to find evidence to validate their claim. 	
<p>Materials (per group)</p> <ul style="list-style-type: none"> ● 2 identical masses (i.e. 200 grams) for each group ● Ring stand or similar structure ● Sewing thread (strong enough to support masses, light enough to break with hand strength) ● 2 spring scales (10 - 20 N range) or digital force probes ● Scissors ● Poster paper ● Markers ● Tape (if needed to to secure posters on the wall) 	
<p>Lesson Length - One 55-minute class period, Lesson can be modified accordingly</p>	



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Suggested Ancillary Materials:

- [Framework for K-12 Science Education](http://www.NAP.edu) (available for free at www.NAP.edu)
- Next Generation Science Standards (available at www.nextgenscience.org)

MIT BLOSSOMS Coaching Template for [“Hanging By A Thread”](#)

Grouping – Groups of four

Investigative Phenomenon:

An applied force on a mass does not always result in acceleration.

Gather Phase

What Is the Teacher Doing?

Tt shows Ss a demonstration set-up where 2 identical masses (i.e. 200 grams) are each suspended by a piece of thread attached to a surface. A separate thread is attached to the base of each mass. Tt informs Ss that the bottom thread will be pulled quickly (jerked) for the first mass, then slowly for the second mass. Tt asks students to make a prediction about which thread will break in each situation - top or bottom.

What are the Students (Ss) Doing?

The students observe a demonstration set-up in the first segment (**0:00 - 2:42**) of the BLOSSOMS video showing how 2 identical masses (i.e. 200 grams) are each suspended by a piece of thread attached to a ring stand (see photo). A separate thread is attached to the base of each mass. The BLOSSOMS video teacher informs Ss that the bottom thread will be pulled quickly (jerked) for the first mass, then slowly for the second mass. The video teacher then asks students to make a prediction about which thread, the bottom thread or the top thread, will break in each situation.



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In the Classroom:

Teachers should “look for” evidence of the following when students are using the practice of **Asking Questions**.

Evidence Bullets (Look Fors):

- pose questions that are testable
- formulate testable hypotheses and pose questions in science that seek evidence relevant to the question
- ask questions that require relevant empirical evidence
- ask questions to determine relationships between independent and dependent variables.

Teachers should “look for” evidence of the following when students are using the practice of **Developing and Using Models**.

Evidence Bullets (Look Fors):

- use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems
- reflect on the components of models of simple systems with uncertain and less predictable factors.

Teachers should “look for” evidence of the following when students are using the practice of **Planning and Carrying Out Investigations**.

Evidence Bullets (Look Fors):

- make careful observations that generate evidence
- recognize patterns in observations and data
- use tools, technologies and/or models (e.g. computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims

In the Classroom:

- After observing the set up on the BLOSSOMS video students, in groups of 4, will collaborate to respond to the questions posed at the break in the video:
 - Which thread breaks when you pull the bottom string quickly?
 - Which thread breaks when you pull the bottom thread slowly?
- Students **ask questions** (see evidence bullets in the teacher column) in order to gather information to make their prediction.
- Once the groups have made a prediction group members collaborate to **create a model** (see evidence bullets in the teacher column) to explain their prediction.
- After the groups have made their predictions and created their initial models explaining their prediction, the teacher plays the second segment (**2:57 - 5:26**) of the BLOSSOMS video. Students respond to the following prompts:
 - Record your observations
 - Explain what is happening through your force diagrams.
 - Which of Newton’s laws best applies to your explanation?
- In groups, students collaborate to **revise/verify their model** (see evidence bullets in the teacher column) based upon their observations of the demonstration to explain how the threads broke. Students will use force diagrams (free body diagrams) to show the forces acting upon the various components of the **system**.
- The teacher then plays the third segment (**5:26 - 8:39**) of the BLOSSOMS video. Students respond to the following prompt:
 - From the measurements you perform and the data you collect, are you able to support or reject your hypothesis?
- Students, as a group, will develop a hypothesis based on their observations thus far.
- Each group collects the necessary materials to perform their own **investigation**.

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Coaching Template ©Next Gen Education LLC

NOTE: Science and Engineering Practices are written in **bold blue font**. Crosscutting Concepts are written in **bold green font**.



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<u>Reason Phase</u>	
<p>Reason: Teachers should “look for” evidence of the following when students are using the practice of <u>Analyzing Data</u>.</p> <p>Evidence Bullets (Look Fors):</p> <ul style="list-style-type: none"> ● Distinguish between causal and correlational relationships. ● Evaluate the impact of new data on a working explanation of a phenomenon <p>Teachers should “look for” evidence of the following when students are using the practice of <u>Developing and Using Models</u>:</p> <p>Evidence Bullets (Look Fors):</p> <ul style="list-style-type: none"> ● Describe ways to use models to reflect on ways to reflect on science concepts or ideas. <p>Teachers should “look for” evidence of the following when students are using the practice of <u>Arguing from Evidence</u>:</p> <p>Evidence Bullets (Look Fors):</p> <ul style="list-style-type: none"> ● Use models to understand arguments ● Use evidence to generate or support explanations ● Reflect on the best evidence supporting an explanation ● Listen and make sense of other’s explanations ● Evaluate and share weaknesses in one’s own arguments and collaborate to seek better evidence. 	<p>Reason:</p> <ul style="list-style-type: none"> ● Students analyze the data (see evidence bullets in the teacher column) from their investigation and determine if there is evidence that supports or refutes their hypothesis. ● Each group will revise their model (see evidence bullets in the teacher column) based upon their evidence to explain how and which of Newton’s Law(s) are demonstrated within the system. ● Each student group will take turns to present their models (e.g., Free Body Diagram) to the other groups along with their explanation of the cause(s) of the phenomenon. ● Once all groups have shared, groups will use evidence from their investigation and their models to argue in support of their explanation (see evidence bullets in the teacher column). ● Teacher facilitates discourse during the group share-outs in order to help the class come to a consensus of an explanation for the causes of the phenomenon and which of Newton’s Laws apply.
<u>Communicate Phase</u>	



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Communicate:

Teachers should “look for” evidence of the following when students are using the practice of **Constructing Explanations**.

Evidence Bullets (Look Fors):

- Revise causal explanations that are supported by data and relate these explanations to current knowledge.
- Explain science observations using evidence.
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future.
- Reflect on the best evidence to support a specific explanation.

Communicate:

- Ss will individually **construct an explanation (e.g., create a model, write explanation)** of the phenomenon **using evidence from their revised models** and **classroom discourse**. In their **explanations** students will identify which of Newton’s Laws of Motion were demonstrated in their investigation.
- The teacher then plays the fourth segment (**8:39 – 11:19**) of the BLOSSOMS video. In this segment, the video teacher provides an explanation of the phenomenon. Students should use this segment as a way of validating their explanations.



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Suggested Prompts Using Crosscutting Concepts to be Used to Stimulate Class Discussion Throughout the Lesson:

- What **causes** the string to break and what is the **effect** of pulling on the string quickly or slowly?
- What are the key components of the **system** within your experimental set-up?
- Draw a diagram that shows how the components of the **system** described in the experimental set-up work together.
- How do the different components of the **system** interact?
- What components of the **system** does the model show? Why are these components shown?
- How would varying the forces acting on the mass **effect** the **stability** of the **system**?
- What **patterns** did you observe in the **system** while you were conducting your experiment?
When you observed the demonstration?

The Gather, Reason, and Communicate Performance Sequence (Moulding & Bybee, 2017)

Gather	Students are provided with a relevant phenomenon or problem that acts as the launching point for them to (1) obtain information by asking questions and defining problems for causes of the phenomenon within and among systems; (2) investigate the interactions of components of systems to determine the changes in terms of flow of energy and cycling of matter; and (3) determine the proportion of components in systems and interactions/feedback among systems. Gathering may include reading, listening, investigating, and using models.
Reason	Students use information they gathered to make sense of phenomena. Reasoning includes analyzing data and information, constructing explanations for the causes(s) of the phenomenon, engineering solutions to problems, and developing arguments for how the evidence supports or refutes explanations or solutions. Reasoning occurs in our brains, but may utilize models, speaking, and writing to organize the relationship between the causes of phenomena and the evidence supporting the explanations.
Communicate	Students communicate their reasoning by developing arguments for how evidence supports explanations. Communicating includes speaking, writing, and/or models to present explanations and arguments to themselves and others.

Moulding, B. & Bybee, R. (2017). *Teaching Science is Phenomenal*. ELM Tree Publishing: Washington, UT. ISBN:978-0-8890674-0-6